CONTROLLER WITH PROGRAMMABLE SERVICE EVENT DISPLAY MODE

Field of the Invention

The present invention relates generally to the field of programmable controllers for homes and/or buildings and their related grounds. More specifically, the present invention relates to such controllers having a programmable service event display mode.

Background of the Invention

Controllers are used on a wide variety of devices and systems for controlling various functions in homes and/or buildings and their related grounds. Some controllers have schedule programming that modifies device parameters such as set points as a function of date and/or time. Some such device or system controllers that utilize schedule programming for controlling various functions in homes and/or buildings and their related grounds include, for example, HVAC controllers, water heater controllers, water softener controllers, security system controllers, lawn sprinkler controllers, and lighting system controllers.

In a typical HVAC system, for example, such controllers can be employed to monitor and, if necessary, control various environmental conditions occurring within a structure. The controller may include a microprocessor that interacts with other components in the system via an I/O interface to regulate the temperature, humidity, venting, and air quality occurring at one or more locations within the structure. An internal sensor located within the controller and/or one or more remote sensors may be employed to sense when the temperature or humidity level reaches a certain threshold level, causing the controller to send a signal to activate or deactivate one or more components in the system.

The controller may be configured to detect when a service event has occurred in one or more of the system components. In certain circumstances, for example, the controller may be configured to detect when one or more system components have malfunctioned or gone offline, or have been in service beyond a recommended period of time and thus require maintenance. Depending on the type of service event detected, the controller can be configured to shut down one or more of the components until the system can be restored.

In some cases, the component triggering the service event may require servicing from the manufacturer or other authorized technician in order to restore the system to normal operation. To notify the user where to obtain service, many manufacturers will place a sticker containing servicing information in an inconspicuous place such as on the inside door panel of the controller housing. After a service event has occurred, the user must know to open the controller door in order to obtain the servicing information. Accordingly, there is a need in the art to better provide the user with servicing information when a fault or other service event has been detected.

Summary of the Invention

The present invention relates to programmable controllers having a programmable service event display mode. A programmable controller in accordance with an illustrative embodiment of the present invention may include an interface for programming a service event display mode in the controller, and/or for displaying servicing information when a service event is detected by the controller. In certain embodiments, the interface may be provided as part of a user interface such as a touch screen or LCD panel/keypad inset within a controller housing. In other embodiments, the

interface may be provided as a separate interface from the user interface, allowing the controller to be programmed from a location outside of the controller.

The controller may be operatively coupled to a number of other system components including, for example, a heating unit, a cooling unit, a ventilation unit, a filtration unit, a UV lamp unit, a humidifier/dehumidifier unit, and/or one or more local or remote sensors. The controller can be configured to check the status of the system components to determine if one or more of the components is functioning properly, has malfunctioned, or has gone offline. An event such as the triggering of a service indicator or the expiration of an equipment service event timer may cause the controller to display servicing information on the display unit, informing the user that servicing may be necessary or recommended. Alternatively, or in addition, the controller may be programmed to automatically contact a designated contractor, a service referral organization, a utility, a retailer, a manufacturer, and/or some other person or organization, requesting service for the detected event. In certain embodiments, the user may send a signal to the controller requesting that certain servicing information be displayed on the display unit, and/or that the controller contact a designated contractor, a service referral organization, a utility, a retailer, a manufacturer, and/or some other person or organization, as desired.

Brief Description of the Drawings

Figure 1 is a block diagram of an illustrative HVAC system employing a controller having a programmable service event display mode;

Figure 2 is a block diagram of the controller and user interface of Figure 1;

Figure 3 is block diagram showing the controller of Figures 1-2 equipped with a programmable interface;

Figure 4 is a flow chart of an illustrative service event routine programmed within a controller equipped with a service event display mode;

Figure 5 is a view of an illustrative HVAC controller equipped with a touch screen interface;

Figure 6 is a pictorial view showing the illustrative controller and user interface of Figure 5 during normal controller operation;

Figure 7 is a pictorial view showing the illustrative controller and user interface of Figure 5 after a service event has been detected;

Figure 8 is a view of another illustrative HVAC controller equipped with a display panel and keypad interface;

Figure 9 is a pictorial view showing the illustrative controller and user interface of Figure 8 during normal controller operation; and

Figure 10 is a pictorial view showing illustrative controller and user interface of Figure 8 after a service event has been detected by the controller.

Detailed Description of the Invention

The following description should be read with reference to the drawings, in which like elements in different drawings are numbered in like fashion. The drawings, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of the invention. Although examples of various programming and operational steps are illustrated in the various views, those skilled in the art will recognize that the many of the examples provided have suitable alternatives that can be utilized. While the

various devices and systems illustrated herein are described specifically with respect to HVAC systems, it should be understood that the present invention could be employed in other systems, including, for example, security systems, lighting systems, sprinkler or drip water systems, audio/video systems, etc.

Referring now to Figure 1, a block diagram of an illustrative HVAC system 10 employing a controller 12 having a programmable service event display mode will now be described. Controller 12 may be operatively connected to one or more system components that can be activated to regulate various environmental conditions such as temperature, humidity and air quality levels occurring within a structure. As shown in Figure 1, for example, the controller 12 can be connected to a heater unit 14 and cooling unit 16 that can be activated to maintain the structure at a particular temperature level. A ventilation unit 18 such as a fan or blower equipped with one or more dampers may be employed to regulate the volume of air delivered to the various rooms of the structure. A filtration unit 20, UV lamp unit 22, and humidifier/dehumidifier unit 24 may also be provided to regulate the air quality and moisture levels within the structure. One or more local and/or remote sensors 26 as well as other system components can also be connected to controller 12 to monitor and regulate the environment, as desired. The system components may be directly connected to a corresponding Input/Output (I/O) port or I/O pins on the controller 12, and/or connected to the controller via a network or the like, as desired.

The controller 12 may include a user interface 28 that allows a user or service technician to transmit signals to and from the controller 12. The user interface 44 can include a touch screen, a liquid crystal display (LCD) panel and keypad, a dot matrix

display, a computer, and/or any other suitable device for sending and receiving signals to and from the controller 12. The controller 12 can be configured to display servicing information on the user interface 28 to notify the user when a fault or malfunction has been detected, or when servicing is necessary or desirable. In certain embodiments, for example, the controller 12 can be programmed to display the name, logo, URL and/or telephone number of a designated contractor, a service referral organization, a utility, a retailer, a manufacturer, and/or some other person or organization when a fault or other service event has been detected in one or more of the system components. In some cases, the controller may display a different name, logo, URL and/or telephone number, depending on the nature of the service event detected and/or the component or unit that needs service. For example, the name, logo, URL and/or telephone number of a designated heating contractor may be displayed when a service event related to the heating system is detected, and the name, logo, URL and/or telephone number of a designated security system contractor may be displayed when a service event related to the security system is detected. In some cases, a service event code and/or short description of the service event may be displayed.

As is discussed in greater detail with respect to Figures 5-10 below, such servicing information can be displayed prominently on a display unit, providing the user with information on where to call for servicing. Alternatively, or in addition, the controller 12 may be programmed to automatically contact a designated contractor, a service referral organization, a utility, a retailer, a manufacturer, and/or some other person or organization, requesting service for the detected event. In one illustrative embodiment, a Telephone Access Module (TAM) 29 may be provided. The TAM 29

may call the appropriate person or organization when a service event is detected by the controller 12. While a TAM is shown in Figure 1, it is contemplated that the controller 12 may notify an appropriate person or organization when a service event is detected via an internet connection, a wireless connection (e.g. cell phone), or any other suitable communication method, as desired.

Figure 2 is a block diagram of the controller 12 and user interface 28 of Figure 1. As illustrated in Figure 2, the controller 12 may include a processor 30 (*e.g.* a microprocessor/CPU), a storage memory 32, a clock 34, and an I/O interface 36 that connects the controller 12 to the various system components illustrated in Figure 1. An internal sensor 38 located within the controller 12 can be employed to measure the temperature, humidity levels and/or other environmental conditions occurring within the structure. In some cases, the sensor 38 may be external to the controller 12.

Figure 3 is a block diagram showing the programmable controller 12 of Figures 1-2 equipped with an interface 40. The interface 40 may be configured to permit the manufacturer or other authorized technician to program the controller 12 to display servicing information on the user interface 40 when a fault is detected in one or more of the system components, or when the controller 12 has determined that a system component requires maintenance or other servicing. For example, the interface 40 can be used to set various equipment service event timers that can be used to remind the user to replace or clean the filter for the filtration unit 20, the pads for the humidifier/dehumidifier unit 24, the UV lamp for the UV lamp unit, the controller batteries, etc., after a certain period of time has elapsed. Other equipment service event timers may, of course, be implemented depending on the particular application.

The parameters for each equipment service event timer can be set to a particular default value, which can then be adjusted using the interface 40, as desired. When the equipment event timer elapses, the controller 12 can be configured to display a service reminder via the user interface 28 of Figure 2 informing the user that service is suggested for the system.

The interface 40 may be provided as part of the user interface 28 described above, or may be provided as a separate interface from the user interface 28. In certain embodiments, for example, the interface 40 may include a menu or screen accessible via the user interface 28 using a security code or password. The menu or screen may be configured to permit only the manufacturer or other authorized technician or organization to program the servicing information into the controller 12, if desired.

In some embodiments, the controller 12 can be programmed at any time before, during or after the controller 12 has been installed. For example, the interface 40 may permit the servicing information to be programmed into the controller 12 in-house at the manufacturer, or at a later time during installation or servicing. In certain embodiments, for example, the interface 40 may include a data port for transferring data to the controller 12, allowing the manufacturer and/or service technician to program the servicing information into the controller 12. For example, using the data port, a service technician or manufacturer may upload servicing information into the controller 12. This information may include, for example, a logo, telephone number, email address, web page URL, etc., of a contractor, service referral organization, retailer, utility or other organization, as desired. This data may be uploaded from a PDA, laptop, or other portable or handheld device, if desired. In some cases, the logo may be in a graphical

representation stored in the memory of the controller. The logo may be in, for example, bitmap, jpeg, gif, tiff, or any other suitable format.

In some embodiments, the interface 40 may be provided as part of a remote interface, allowing the manufacturer or other authorized technician to program the controller 12 at a location outside of the controller 12. In certain embodiments, for example, the interface 40 may include a receiver that can be used to receive servicing information over a wireless connection, such as an infrared connection, over a cell phone network, over a wired connection such as a telephone line, or any other suitable connection. Alternatively, or in addition, the interface 40 may be connected to the World Wide Web (WWW), which may allow the servicing information to be uploaded into the controller 12 from a remote location across the WWW.

Referring now to Figure 4, an illustrative service event routine programmed within a controller equipped with a service event display mode will now be described. The service event routine, indicated generally by reference number 42, may begin from a normal controller operation mode, indicated generally by block 44. From the normal controller operation mode 44, the controller may be configured to check the operating status of one or more of the system components to determine if the system components are functioning properly, as indicated generally by block 46. In some embodiments, the controller may periodically poll each of the system components and obtain current status information. If the controller receives a signal from one or more of the system components indicating a system fault, loss of power or other service indicator, the controller can be configured to display servicing information such as the name, logo, URL, telephone number and/or other information for a designated contractor, service

referral organization, manufacturer, retailer, utility and/or other person or organization. The controller may also be configured to display a service event code, a description of the fault, and/or any other useful information, as indicated generally by block 48. In some cases, different servicing information can be displayed depending on which system component(s) indicated a positive service indicator. For example, one contractor logo and telephone number may be displayed if the cooling system provided a service indicator, and another contractor logo and telephone number may be displayed if the heating system provided a service indicator. The servicing information can be displayed temporarily for a certain period of time until the controller is reset and/or until the faulty system component is restored to normal operation.

If the controller does not receive a service indicator from one or more of the system components, the controller can be configured to determine whether any of the equipment service timers (if any) have elapsed, as indicated generally by block 50. If, for example, the controller determines that the filter for the filtering unit has been in use for a certain period of time and likely requires replacement, the controller can be configured display a logo and telephone number for an authorized filter contractor or dealer. Information about the type of filter to replace as well as other pertinent servicing information can also be displayed, as desired.

In certain embodiments, the controller 12 can include a help mode that can be activated by the user to obtain servicing information. As indicated by block 52, for example, the user may send a signal to the controller via a "help" button or other similar command. When the controller 12 receives a signal from the user requesting help, as indicated generally by block 54, the controller can be configured to display servicing

information such as the logo, telephone number, etc. of a designated contractor, service referral organization, manufacturer, retailer, utility and/or other person or organization as desired. The controller can be configured to display the servicing information irrespective of whether a service indicator or expired equipment service event timer has been detected.

While the illustrative service event routine 42 shown in Figure 4 includes a particular sequence of events which occur during the routine 42, it should be understood that the particular order at which each step occurs can be altered, if desired. For example, the controller may be configured to perform each step in parallel, or in a sequence different from that illustrated in Figure 4. In addition, one or more steps in the service event routine 42 may be eliminated, if desired, depending on type of controller employed.

Figure 5 is a view of an illustrative controller 56 equipped with a user interface 58 for displaying servicing information when a service event is detected. In the illustrative embodiment of Figure 5, user interface 58 includes a touch screen 60 configured to display information and transmit signals to and from the controller 56. Some examples of suitable touch screens 60 for use with the controller 56 may include resistive, capacitive, infrared or surface acoustic wave (SAW) type touch screens. The touch screen 60 may be either inset or recessed within a controller housing 62, as shown in Figure 5, or may be provided as a separate component for use with a personal digital assistant (PDA), PC computer, or other remote device. In certain embodiments, the touch screen 60 can be provided as part of a liquid crystal display (LCD) panel, cathode ray tube (CRT), dot matrix display, or other suitable display device.

Figure 6 is a pictorial view showing the illustrative controller 56 and user interface 58 of Figure 5 during normal controller operation. As shown in Figure 6, the touch screen 60 may be configured to display a main menu screen 64 that provides the user with information about the operational status of the controller 56, the current inside and outside temperature, the current time and day of week, the current heat and/or cool set point, as well as other operational information. The main menu screen 64 may be the default screen that appears on the touch screen 60 when the controller 56 is initially activated, after a loss of power has occurred, or after no activity has been detected by the user interface 58 for a certain period of time (*e.g.* after 1 minute of non-activity).

By pressing various icon buttons on the touch screen 60, the controller 56 can be configured to cycle through one or more menus or screens to view and, if desired, modify various operational settings within the controller 56. For example, the user can use the touch screen 60 to adjust the current temperature or humidity levels, change the clock or date settings on the controller 56, set a vacation schedule on the controller 56 that can be run while the user is away, etc. The touch screen 60 may also be used to check the status of the various system components connected to the controller 56.

Figure 7 is a pictorial view showing the illustrative controller 56 and user interface 58 of Figure 6 after a service event has been detected. As shown in Figure 7, the controller 56 can be configured to display a service event display screen 66 on the touch screen 70 that informs the user that a service event has been detected. The service event display screen 66 may include, for example, a logo 68 and telephone number 70 indicating where to call for servicing or replacement. Other information in addition to, or in lieu of, the logo 68 and telephone number 70 may also be provided on the service

event display screen 66, as desired. In some cases a service event code and/or short description of the service event may also be displayed, as shown at 69. The service event code may help a service technician diagnose the problem on the phone and possibly help provide a corrective action to the user via the phone. Also, the service event code may help the service technician determine what parts to order or bring to correct the problem.

A short description of the service event may help the user identify and possibly correct the problem. For example, if the service event was triggered as a result of the controller 56 determining that an equipment service event timer has expired, the controller 56 can be configured to display the particular device requiring service, and a recommended course of action. If, for example, an equipment service event timer for the filter has expired, the controller 56 can be configured to display the text "REPLACE FILTER" or other similar text on the touch screen 60, along with an appropriate logo, telephone number, and/or address for an authorized dealer of the filter, along with the part number of the filter, if desired. Similar messages can be displayed for other system components such as the humidifier pad, UV lamp, and batteries, as necessary.

The service event display screen 66 can be triggered when the controller 56 detects a fault in one or more of the system components, or when an equipment service event timer previously programmed in the controller 56 expires. In certain embodiments, the service event display screen 66 can be activated by the user by pressing one or more of the icon buttons on the touch screen 60, causing the controller 56 to display the desired servicing information on the screen 60.

Figure 8 is a view of another illustrative controller 72 equipped with a user interface 74 for displaying servicing information when a service event is detected. In the illustrative embodiment of Figure 8, user interface 74 includes a display panel 76 and a series of buttons 78, 80 that can be pressed by the user to scroll through various menus or screens displayable on the display panel 76. The display panel 76 can include any number of suitable display devices, including, for example, a backlit LCD panel or LED screen.

Figure 9 is a pictorial view showing the illustrative controller 72 and user interface 74 of Figure 8 during normal controller operation. As shown in Figure 9, the controller 72 can be configured to display a main menu screen 82 on the display panel 76, similar to that described above with respect to Figure 6.

As shown in Figure 10, the controller 72 can be configured to display a service event display screen 82 on the display panel 76 that informs the user that a service event has been detected. The service event display screen 82 may include, for example, a logo 86 and telephone number 88 indicating where to call for servicing or replacement. Other information in addition to, or in lieu of, the contractor logo 86 and telephone number 88 may also be provided on the service event display screen 84, as desired.

The service event display screen 84 can be triggered when the controller 72 detects a fault in one or more of the system components, or when an equipment service event timer previously programmed in the controller 72 expires. In certain embodiments, the service event display screen 84 can be activated by the user by pressing one of the buttons 78, 80 (*e.g.* a help button), causing the controller 72 to display the desired servicing information on the display panel 76.

Having thus described the several embodiments of the present invention, those of skill in the art will readily appreciate that other embodiments may be made and used which fall within the scope of the claims attached hereto. Numerous advantages of the invention covered by this document have been set forth in the foregoing description. It will be understood that this disclosure is, in many respects, only illustrative. Changes can be made with respect to various elements described herein without exceeding the scope of the invention.